the channel processors by a mixer and sending the mixed signals to a still post stage on one transmission line; and in the post stage, selecting one of the plurality of signals from the channel processors by a satellite tuner and demodulating the selected signal, inverting the demodulated signal on the frequency axis to be returned to be a signal receivable on a TV receiver, and then receiving the signal on the TV receiver.

3. Detailed Description of the Invention

[Field of the Invention]

The present invention relates to a satellite signal reception system for receiving satellite signals of a plurality of channels scattered over a wide band, rearranging the channels, and sending the signals to a post stage, so that a channel is selected in the post stage and received by a TV receiver.

[Prior Art]

Launching of a communication satellite for commencement of delivery service is planned. The following system is in consideration. Delivery signals from a plurality of channels from the satellite (referred to as "satellite signals" in this specification) are received by an antenna, frequency-converted by a CS converter, and sent to a post stage by one transmission line. In the post stage, a desired channel is selected by a satellite tuner and received by a TV receiver.

[Problems to be Solved by the Invention]

The satellite signals of a plurality of channels sent from the communication satellite are over a band of about 400 MHz, and reception of all the channels is re-

Japanese Laid-Open (Kokai) Publication No. 2-140022

(Translation)

Japanese Laid-Open (Kokai) Publication No. 2-140022

Laid-Open Publication Date: May 29, 1990
Application Number: 63-293399
Filing Date: November 18, 1988
Inventor: J. UEMURA
Applicant: Maspro Denkoh Corp.

Specification

1. Title of the Invention
   Satellite signal reception system

2. Claim

A satellite signal reception system, characterized by demultiplexing a signal received by an antenna from a communication satellite by an orthogonal polarization demultiplexer into at least one vertical polarization channel signal and at least one horizontal polarization channel signal: converting each of the polarization signals into a first intermediate frequency signal by a CS converter; selecting and frequency-converting one of the at least one vertical polarization channel signal to form a signal inverted on a frequency axis and sending the inverted signal to a post stage by a channel processor: selecting and frequency-converting one of the at least one horizontal polarization channel signal to form a signal having a different frequency, inverted on the frequency axis and sending the inverted signal to a post stage by a different channel processor; in the stage post to the channel processors, mixing the signals from

quired in only few cases. Accordingly, it is rare that signals of all the channels received at a satellite signal reception point are sent to a post stage. In general, only the satellite signals of a desired channel are extracted and sent to the post stage. However, extracting a signal of the desired channel with the frequency maintained requires a transmission system having a wide band characteristic for sending the signal to the post stage, and also requires an extra equalizer and the like for compensating for the frequency-attenuation characteristic of the transmission line.

An objective of the present invention is to provide a convenient satellite signal reception system for sending satellite signals of a plurality of channels to a post stage while being compressed in a narrow band with a high frequency utilization efficiency, and inverting the signals on a frequency axis in order to prevent the signals from being easily received by a conventional satellite tuner so that a pay system is easily introduced.

[Means for Solving the Problems]

In order to achieve the above-described objective, the present invention has means described in the claim and functions as follows.

[Function]

From the communication satellite, signals of a plurality of channels are sent by both vertical polarization and horizontal polarization. These signals are demultiplexed by an orthogonal polarization demultiplexer into vertical polarization channel signals and horizon-

tal polarization channel signals. The vertical polarization channel signals are converted into first intermediate frequency signals by a CS converter and classified by the number of channels which are intended to be received. Then, the signals are respectively subjected to channel processors. The horizontal polarization channel signals obtained by the orthogonal polarization demultiplexer are frequency-converted into first intermediate frequency signals by a different CS converter and classified by the number of channels which are intended to be received. Then, the signals are respectively subjected to different channel processors.

The channel processors select the first intermediate frequency signals of different channels from one another. The selected signals are frequency-converted into signals having different frequencies and output. For the channel selection and frequency conversion, a frequency conversion of extracting a frequency of a sum component of a local oscillation signal and the signal in question, and a frequency conversion of extracting a frequency of a difference component of the local oscillation signal and the signal in question, are used. As a result, the signals output from the channel processors are inverted on a frequency axis and cannot be easily received unless re-inverted. The output signals are arranged with no space therebetween so that the frequency band of each signal obtained as a result of the frequency conversion does not use an extra band.

The output signals from the channel processors are mixed by a mixer and sent to a post stage by one transmission line. In the post stage, a satellite tuner is

connected to the transmission line. One channel of the signals inverted on the frequency axis is selected and demodulated. For the channel selection, frequency conversion is used. The conversion of extracting a difference component of the local oscillation signal and the signal in question, and the conversion of extracting a difference component of the signal in question and the local oscillation signal, are both used. In the former case, since the output signal is inverted on the frequency axis, usual signal processing is performed in steps post to the demodulation. In the case of the latter frequency conversion, since the output signal is not inverted on the frequency axis, the output signal of the selected channel is substantially inverted on the frequency axis into the original state by, for example, using a device having an inverted S-type characteristic for demodulation.

In this manner, a receivable demodulated output is sent to a TV receiver connected to the satellite tuner. Therefore, the signal of the selected channel can be received by the TV receiver.

(Examples)

Hereinafter, figures showing examples according to the present invention will be described.

Figure 1 shows a system diagram of a satellite signal reception system. The letter S represents a re-transmission system, the letter T represents a transmission system, and the letter R represents a reception system. In the re-transmission system S, reference numeral 1 represents a CS antenna for receiving a satel-

Communication satellite ≡ CS

lite signal in a 12 GHz band from the communication satellite. Reference numeral 2 represents an orthogonal polarization demultiplexer, which is also simply referred to an OMT. Reference numerals 3 and 4 represent CS converters for frequency-converting a 12 GHz band signal into a CS first intermediate frequency signal in a 1 GHz band. Reference numerals 5 and 6 represent distributors. Reference numerals 7a, 7b, 7c and 7d represent channel processors. The structure of the channel processors will be described below. Reference numeral 8 represents a mixer, and reference numerals 9 represents a BS antenna for receiving a 11.7 to 12.0 GHz satellite signal. Reference numeral 10 represents a BS converter for converting a satellite signal from the BS antenna 9 into a BS first intermediate frequency signal in a 1.0 to 1.3 GHz band. Reference numeral 11 represents a band-pass filter for passing the BS first intermediate frequency signal therethrough and removing a noise component generated in the band of the CS first intermediate frequency signal from the BS converter 10. Reference numeral 12 is a branch device. Reference numeral 12a represents an input terminal, reference numeral 12b represents an output terminal, and reference numeral 12c represents a branch output terminal. The branch device 12 is used for mixing.

BS ≡ broadcast satellite

Then, the transmission system T will be described. Reference numeral 13 represents a transmission line, for which a coaxial cable is used for example. In some cases, an amplifier 38 is provided on the transmission line for amplifying the BS first intermediate frequency signal or the CS first intermediate frequency signal. Reference numeral 14 represents a branch device. Reference numeral 15 represents a drop wire for connecting the branch de-

vice 14 and the reception system R to each other. As the drop wire 15, a coaxial cable is used for example.

Then, the reception system R will be described. Reference numerals 16a, 16b, ... represent satellite tuners. The structure of the satellite tuners 16a, 16b will be described below. Reference numerals 17a, 17b, ... represent TV receivers such as monitors.

Reference numeral 18 represents an output terminal of the re-transmission system S, and reference numeral 19 represents an input terminal of the reception system R.

Next, the structure of the channel processor 7a will be described. Figure 2 is a block circuit diagram of the channel processor. In the figure, reference numeral 20 represents an input terminal, and reference numeral 21 represents an output terminal. Reference numeral 22 represents a wide band amplifier for amplifying a signal in the CS first intermediate frequency band of 1350 to 1750 MHz. Reference numeral 23 represents a former-stage mixer. Reference numeral 24 represents a variable attenuation circuit for setting an attenuation amount based on an attenuation amount control signal applied to a control input terminal 24a. Reference numeral 25 represents a band-pass filter for passing, for example, a signal in a second intermediate frequency band of 385 to 415 MHz therethrough and blocking signals of the other bands. Reference numeral 26 represents an intermediate frequency amplifier for amplifying a signal of a second intermediate frequency. Reference numeral 27 represents an AGC control circuit for providing a well-known AGC

loop so that the signal levels are uniform at an output of the intermediate frequency amplifier. The AGC control circuit 27 outputs the attenuation amount control signal for setting the attenuation amount of the variable attenuation circuit 24. Reference numeral 28 represents a former-stage variable oscillator, reference numeral 29 represents a frequency divider, and reference numeral 30 represents a frequency control circuit. Reference numeral 31 represents an intermediate frequency amplifier which has the same structure as that of the intermediate frequency amplifier 26 and is provided as necessary. Reference numeral 32 represents a latter-stage mixer, and reference numeral 33 represents a band-pass filter. The band-pass filter 33 passes a signal in the CS first intermediate frequency band therethrough and blocks signals of the other bands. Reference numeral 34 represents a wide band amplifier which has the same structure as that of the wide band amplifier 22 and is provided as necessary. Reference numeral 35 represents a latter-stage variable oscillator, reference numeral 36 represents a former-stage frequency setting circuit, and reference numeral 37 represents a latter-stage frequency setting circuit.

The structure of the satellite tuner 16a will be described. Figure 3 is a block circuit diagram of the satellite tuner. Reference numeral 40 represents an input terminal, reference numeral 41 represents a video signal output terminal, and reference numeral 42 represents an audio signal output terminal. Reference numeral 43 represents a mixer, and reference numeral 44 represents a band-pass filter. The band-pass filter 44 passes, for example, a signal in the second intermediate frequency

band of 385 to 415 MHz therethrough and blocks signals of the other bands. Reference numeral 45 represents an FM demodulation circuit, for which a circuit exhibiting an inverted S-type frequency-demodulated output voltage characteristic is used. The center frequency of the demodulated signals is set to be 400 MHz, which is the center frequency of the band of frequencies allowed to pass through the band-pass filter 44. Reference numeral 46 represents a variable oscillator, reference numeral 47 represents a frequency setting circuit, and reference numeral 48 represents a channel selection key. Reference numeral 48a represents a channel setting section, and reference numeral 48b represents a satellite setting section. Reference numeral 49 represents a switching circuit for making contact X or contact Y conductive in accordance with a switching control signal applied to a control terminal 49a. Reference numeral 50 represents a polarity inverting circuit. As the polarity inverting circuit, a video amplifier of one transistor is used for example. Reference numeral 51 represents a video signal processing circuit, and reference numeral 52 represents an audio signal processing circuit.

Next, the operation of the satellite signal reception system having the above-described structure will be described. First, in the re-transmission system S, a BS satellite signal of the 11.7 through 12.0 GHz band from a broadcast satellite is received by the antenna 9 and converted into a BS first intermediate frequency signal in the 1.0 to 1.3 GHz band by the BS converter 10. The resultant signal passes through the band-pass filter 11 and is applied to the branch device 12.

A satellite signal of a 12.3 through 12.7 GHz band from the communication satellite is received by the CS antenna 1 and demultiplexed into a vertical polarization channel signal and a horizontal polarization channel signal by the orthogonal polarization demultiplexer 2. The vertical polarization channel signal is converted into a CS first intermediate frequency signal in a 1.350 to 1.750 GHz band by the CS converter 3. The horizontal polarization channel signal is also converted into a first intermediate frequency signal in the 1.350 to 1.750 GHz by the CS converter 4. A signal spectrum at output A of the CS converter 3 is shown in Figure 4(A), and a signal spectrum at output B of the CS converter 4 is shown in Figure 4(B). Then, the output signal from the CS converter 3 is distributed by the distributor 5. In the channel processor 7a, the signal of channel Ch1 in Figure 4(A), for example, is selected and then frequency-converted. Similarly in the channel processor 7b, the signal of channel Ch10 in Figure 4(A), for example, is selected and then frequency-converted. The output signal from the CS converter 4 is distributed by the distributor 6. In the channel processor 7c, the signal of channel Ch11 in Figure 4(B), for example, is selected and then frequency-converted. In the channel processor 7d, the signal of channel Ch19 in Figure 4(B), for example, is selected and then frequency-converted. The channel processors 7a, 7b, ... process the signals as follows. The oscillation frequencies of the former-stage variable oscillator 28 and the latter-stage variable oscillator 35 are respectively set by the former-stage frequency setting circuit 36 and the latter-stage frequency setting circuit 37. The signal applied to the input terminal 20 passes through the wide band amplifier

22, the former-stage mixer 23, and the variable attenuation circuit 24. Only the signal of the selected channel passes through the band-pass filter 25, and the intermediate frequency amplifiers 26 and 31, and then frequency-converted by the latter-stage mixer 32. The output from the latter-stage mixer 32 has a preset frequency so that the outputs from the channel processors 7a, 7b, ... do not interfere with one another when being mixed, and do not use an extra frequency space. The output from the latter-stage mixer 32 passes through the band-pass filter 33 and the wide band amplifier 34 and then is output from the output terminal 21. The level of the output signal at the output terminal 21 is stable due to the well-known AGC provided by the AGC control circuit 27. The frequency of the output signal is stable due to the well-known AFC provided by the frequency divider 29 and the frequency control circuit 30. One example of the relationship among the frequencies of the input and output signals of the channel processors 7a, 7b, ... and the oscillation frequencies of the variable oscillators 28 and 35 is shown in Table 1.

Table 1

Channel processor	CS first intermediate frequency signal to be selected (f1)	Oscillation frequency of former-stage variable oscillator 28 (f2)	Arrangement order in Figure 4(C)	Oscillation frequency of latter-stage variable oscillator 35 (f3)	Center frequency of the output signal (f4)
7a	Ch 1 1365MHz	1765MHz	1	965MHz	1365MHz
7b	Ch 10 1725MHz	2125MHz	2	1000MHz	1400MHz
7c	Ch 11 1385MHz	1785MHz	3	1035MHz	1435MHz
7d	Ch 19 1705MHz	2105MHz	4	1070MHz	1470MHz

In this example, $f2=f1+f0$ (400MHz), $f3=f4-f0$ (400MHz).
The combination of $f2=f1-f0$ (400MHz), $F3=f4+f0$ (400MHz) is usable.

Next, the output signals from the channel processors 7a, 7b, ... are mixed by the mixer 8. A signal spectrum at point C after the mixture is shown in Figure 4(C). It is appreciated from Figure 4(C) that four signals received are efficiently accommodated in the CS first intermediate frequency band. In the figure, "←" represents that the signal in the band is inverted on the frequency axis. Such a signal is regarded as being scrambled as can be understood from the fact that when such a signal is received by the TV receiver after FM-demodulated, the image is too disordered to be viewable. Then, the branch device ~~14~~ 12 mixes the BS first intermediate frequency signal and the CS first intermediate frequency signal from the mixer 8. A signal spectrum at point D is as shown in Figure 4(D). Section P represents a schematic spectrum of the BS first intermediate frequency signal, and section Q represents a schematic spectrum of the CS first intermediate frequency signal. The re-transmission system S sends the signal in Figure 4(D).

Next, the transmission system T transmits the signal from the re-transmission system through the transmission line 13, and the branch device 14 distributes the signal to the reception systems R.

In the reception system R, a desired channel of a desired satellite is selected by the satellite tuner 16a. The signal processing performed at this point by the satellite tuner 16a will be described. First, for receiving a satellite signal channel from the broadcast satellite, the broadcast satellite is selected by the satellite setting section 48b of the channel selection

broadcast satellite = BS

satellite setting section 48b is to select BS signal received at antenna 9 or CS signal received at antenna ?

no need to be converted by block 50

key 48, and a desired channel is selected by the channel setting section 48a. The switching circuit 49 is connected to make contact Y conductive, and the frequency setting circuit 47 oscillates a signal at an oscillation frequency corresponding to the desired channel, to the variable oscillator 46. Accordingly, the BS first intermediate frequency signal applied to the input terminal 40 is frequency-converted by the mixer 43, and only the intermediate frequency signal of the desired channel passes through the band-pass filter 44. This signal is demodulated by the FM demodulation circuit 45. The video signal is processed by the video signal processing circuit 51, and the audio signal is processed by the audio signal processing circuit 52. The processed signals are output to a post stage.

CS

For receiving a satellite signal channel from the communication satellite, the communication satellite is selected by the satellite setting section 48b of the channel selection key 48, and a desired channel is selected by the channel setting section 48a. The switching circuit 49 is connected to make contact X conductive. Except that the polarity inverting circuit 50 is inserted after the demodulation circuit 45 and the switching circuit 49, the rest is the same as in the case of receiving from the broadcast satellite. The states of the signals in the satellite tuner are shown in Table 2.

need to be converted by block 50

Table 2

Satellite to be selected	Channel to be selected	Signal at input terminal 40		Oscillation frequency of variable oscillator 46	Output polarity of FM modulation circuit 45	Output polarity at point Z in Figure 3
		Center frequency	Signal state			
Broadcast satellite	Ch 11	1241.28MHz	Normal	1641.28MHz	Normal	Normal
	Ch 15	1318.00MHz	Normal	1718.00MHz	Normal	Normal
Communication satellite	Ch 1	1365MHz	Inverted	1765MHz	Inverted	Normal
	Ch 10	1400MHz	Inverted	1800MHz	Inverted	Normal
	Ch 11	1435MHz	Inverted	1835MHz	Inverted	Normal
	Ch 15	1470MHz	Inverted	1870MHz	Inverted	Normal

BS

CS

"Signal state" represents whether the signal is normal or inverted on the frequency axis.

Regarding the polarity of the output signal, "normal" indicates that the polarity of the original signal, and "inverted" indicates that the polarity of the output signal is opposite to the polarity of the original signal.

ch1, ch10 = V
ch11, ch19 = H
(see page 10)
=) 48a selects V or H

The satellite signal reception system can be made a pay system by renting the satellite tuner 16a shown in the example to the subscribers. Alternatively, the switching circuit 49 of the satellite tuner 16a can be structured to be switched by a key, which is rented to the subscribers.

In the above example, a plurality of the reception systems R are provided in the satellite signal reception system. Needless to say, only one reception systems R can be provided. In the above example, two vertical polarization channels and two horizontal polarization channels are received. Needless to say, the number of the channels can be increased.

(Effect of the Invention)

As described above, according to the present invention, a satellite signal scattered in a wide frequency band is selected and frequency-converted and sent to a post stage after compressed in a narrow frequency band. Accordingly, the frequency utilization efficiency is high, and the device provided on the transmission line can be low-cost.

For the channel selection and frequency conversion, the conversion by which the signal is inverted on the frequency axis is performed. Therefore, a signal can be non-receivable by the conventional BS tuner or the like. Accordingly, the system can be easily made a pay system without separately providing a scramble circuit, which is financially advantageous.

4. Brief Description of the Drawings

The figures are regarding an example of the present invention. Figure 1 is a system diagram of the satellite signal reception system; Figure 2 is a block circuit diagram of a channel processor; Figure 3 is a block circuit diagram of a satellite tuner; and Figure 4 shows a schematic signal spectrum in each section of the system.

1 ... antenna; 2 ... orthogonal polarization demultiplexer; 3, 4 ... CS converter; 7a, 7b, 7c, 7d ... channel processor; 8 ... mixer; 13 ... transmission line; 16a, 16b, 16c ... satellite tuner; 17a, 17b, 17c ... TV receiver.

12 GHz band

Fig. 1

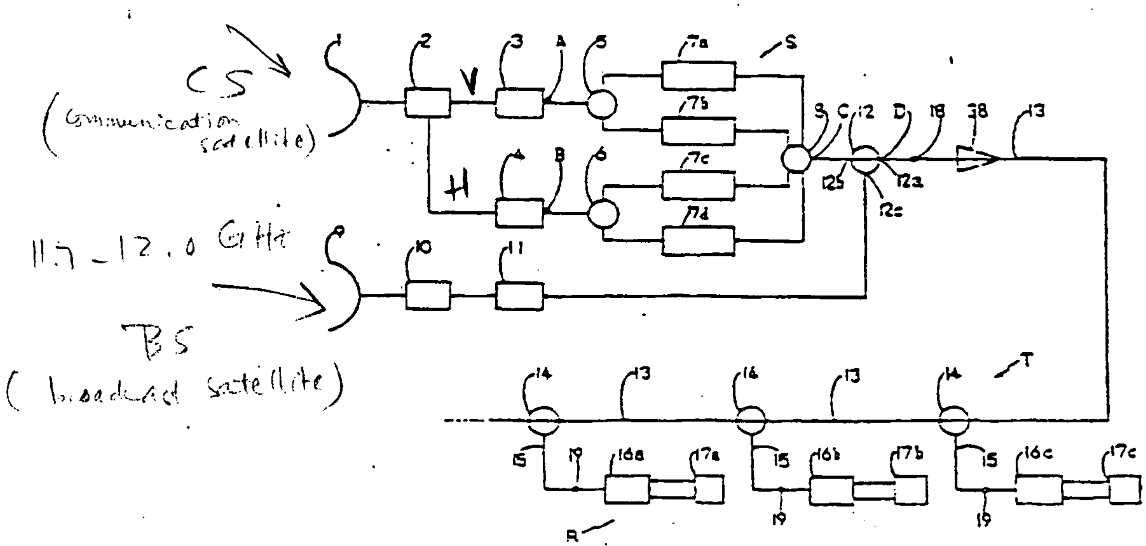

Fig. 2

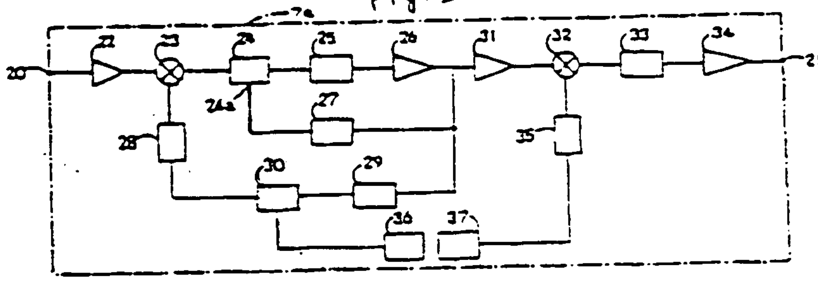

Fig. 3

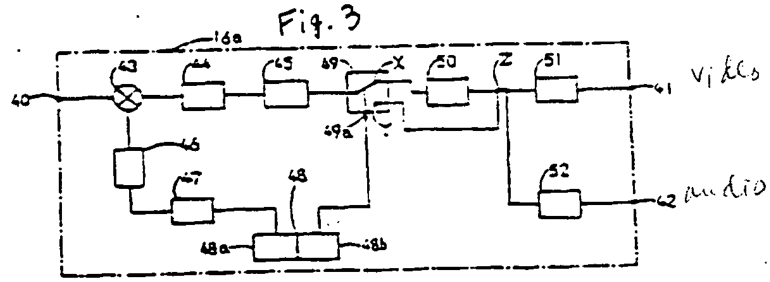

Fig. 4